GEN DKT 98-68

Raytheon

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Office of the Secretary
Federal Communications Commission
Washington, DC 20554

Dear Sir or Madam:

Subject: Comments on ~~FCC~~ 98-68

The expanding applications of the Global Positioning System for non-military and commercial use has the potential for huge economic gains for every sector of the worldwide economy. The benefits of GPS location and timing capabilities are potentially as significant as the introduction of the internet. Any reduction in the availability or integrity of the GPS signal would threaten those gains.

As the developer of the FAA's Wide Area Augmentation System and many other GPS-based products and systems, Raytheon is extremely concerned about the long-term viability of satellite based navigation systems. Any encroachment into the GPS frequency spectrum threatens to disrupt or negate the many benefits of these systems and products.

We recognize that the proposed allowable interference limits for Mobile Satellite Services are well supported and accepted by the aviation community. However, the ground-based community, including WAAS reference stations, pose a set of requirements that have not been adequately considered.

The attached analysis briefly illustrates how the proposed rule change threatens the availability of the WAAS system. It illustrates that there are very real conditions under which the proposal could make a WAAS reference station unavailable for an indefinite period of time. This is clearly not in the public interest.

In summary, Raytheon is strongly opposed to the current proposal in general and the interference levels in particular. GPS is a valuable national asset that must be guarded and this proposal does not accomplish that goal.

Very truly yours,

Michael M. Hoeffler, Vice President
Air Traffic Control

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Analysis of Interference Levels proposed in FCC 98-68

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Background

The FCC has issued a Notice of Proposed Rulemaking (NPRM) (98-68) that includes a proposed allowable interference limit for Global Mobile Personal Communication for Satellite (GMPCS) in the Global Positioning System (GPS) band.

Raytheon is prime contractor for the FAA on a GPS-based system- the Wide Area Augmentation System (WAAS). WAAS will eventually become the cornerstone system for civil air navigation. It will include up to 70 ground-based reference stations across North America. These reference stations contain reference receivers that receive GPS signals, make range and phase measurements and transmit the measurements via land lines to a central processing location. The central processors compute correction and integrity information, which is then relayed via geosynchronous satellite to WAAS users. The quality of correction and overall availability of WAAS service is dependent on the ability of the reference stations to successfully make measurements. Interference is one factor that can degrade WAAS performance.

WAAS Reference Receiver Specifications

The key specification for this analysis is the interference-to-signal ratio performance requirement for the reference receiver. The WAAS requirement for wideband interference is specified as a function of interferor elevation angle and bandwidth. For this analysis the worst case of wideband interference will be considered:

Elevation Angle	I/S Requirement (Wideband Interference) - L1-C/A Acquisition
> 5 degrees	24 dB
Between 2.5 and 5 degrees	Linear interpolation between 24 dB and 34 dB
<2.5 degrees	34 dB

Analysis

We wish to compute the separation distance between the proposed GMPCS interfering source and the WAAS reference receiver required to prevent degradation. The following assumptions are made:

Parameter	Value
Receiver bandwidth	20 MHz (13 dB MHz)
Interference power spectral density	-70 dBW/MHz
WAAS minimum required acquisition elevation angle	5 degrees
Interference elevation angle	0 degrees
Reference receiver antenna gain relative to zenith at 5 degrees	-19.5 dB
Reference receiver antenna gain relative to zenith at 0 degrees	-21 dB
Nominal WAAS received signal power (zenith)	-160 dBW
Receive band center frequency	1575.42 MHz
Interference margin	6 dB

The transmitted interference power is -70 + 13 = -57 dBW. At 0 degrees elevation angle, the antenna gain of -21 dB will result in a received interference power level of -78 dBW (not including path loss).

The arriving signal power at zenith is -160 dBW. At 5 degrees, the antenna gain of -19.5 dB will result in a received signal power level of -179.5 dBW.

From above, the required I/S performance for an interferor at 0 degrees elevation is 34 dB. An interference margin of 6 dB is assumed to account for variations in antenna pattern, propagation effects, and background noise levels. This results in an effective I/S threshold of 28 dB.

The required free space path loss to reduce the interference power to this I/S is computed as

$$\frac{I_r}{S} = I - L_p - S$$

L_p= -78 - (-179.5) -28 = 73.5 dB.

We therefore compute the required path distance using:

$$-32.44 + 20 \log D_{km} + 20 \log f_{MHz} = 73.5 \text{ dB}$$

For f= 1575.42, **D = .071 km or 71 meters**.

Conclusion

Given the mobile nature of the proposed service and the required separation distance of 71 meters, there is significant risk that performance degradation would occur at one or more WAAS reference receiver sites if the proposed interference limits are approved.

For example, the WAAS reference station at the Billings Flight Service Station is located on public airport property and the reference site antenna locations are easily within 71 meters of locations where GMPCS transmitters could be used.

Given that WAAS is a safety critical part of the planned future for commercial and general aviation this risk is clearly not warranted. Rejection of the proposed limit is recommended.